

# (12) UK Patent Application (19) GB (11) 2 285 135 (13) A

(43) Date of A Publication 28.06.1995

(21) Application No 9425034.7

(22) Date of Filing 09.12.1994

(30) Priority Data

(31) 08168702

(32) 16.12.1993

(33) US

(71) Applicant(s)

Hewlett-Packard Company

(Incorporated in USA - California)

3000 Hanover Street, Palo Alto, California 94304,  
United States of America

(72) Inventor(s)

Michael K Dempsey

(74) Agent and/or Address for Service

Williams, Powell & Associates

34 Tavistock Street, LONDON, WC2E 7PB,  
United Kingdom

(51) INT CL<sup>6</sup>

A61B 5/00

(52) UK CL (Edition N )

G1N NEAX NESS N19B1A N19B2P N19X5 N30PX

N30P1 N30P2 N30P4 N30P5 N30R

G4H HNHE H13D H14G H60

U1S S1025 S1056

(56) Documents Cited

US 4958645 A

(58) Field of Search

UK CL (Edition N ) G1N NEAE NEAN NEAX NESS

INT CL<sup>6</sup> A61B 5/00 , G08C 17/02

Online: WPI

(54) Medical emergency response system

(57) An emergency medical response system (10) includes a monitor (15) for detecting a potential emergency medical condition, a position receiver (25) such as a GPS receiver (26) or an infrared receiver, and a transmitter (27). When an emergency medical condition is detected, the transmitter (27) is energized to send the current position of a patient wearing the system to an EMS site. The nature of the medical emergency would also typically be transmitted. Other information which may be stored at the system, such as the patient's name, medical history, and the like, may also be transmitted. Information on patient position and current medical condition detected by the monitor (15) may continue to be transmitted after an emergency is detected.

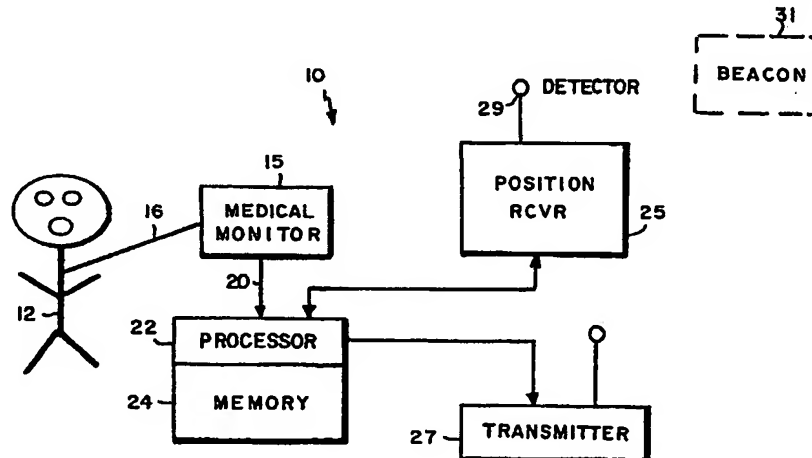


FIG. 1A

GB 2 285 135 A

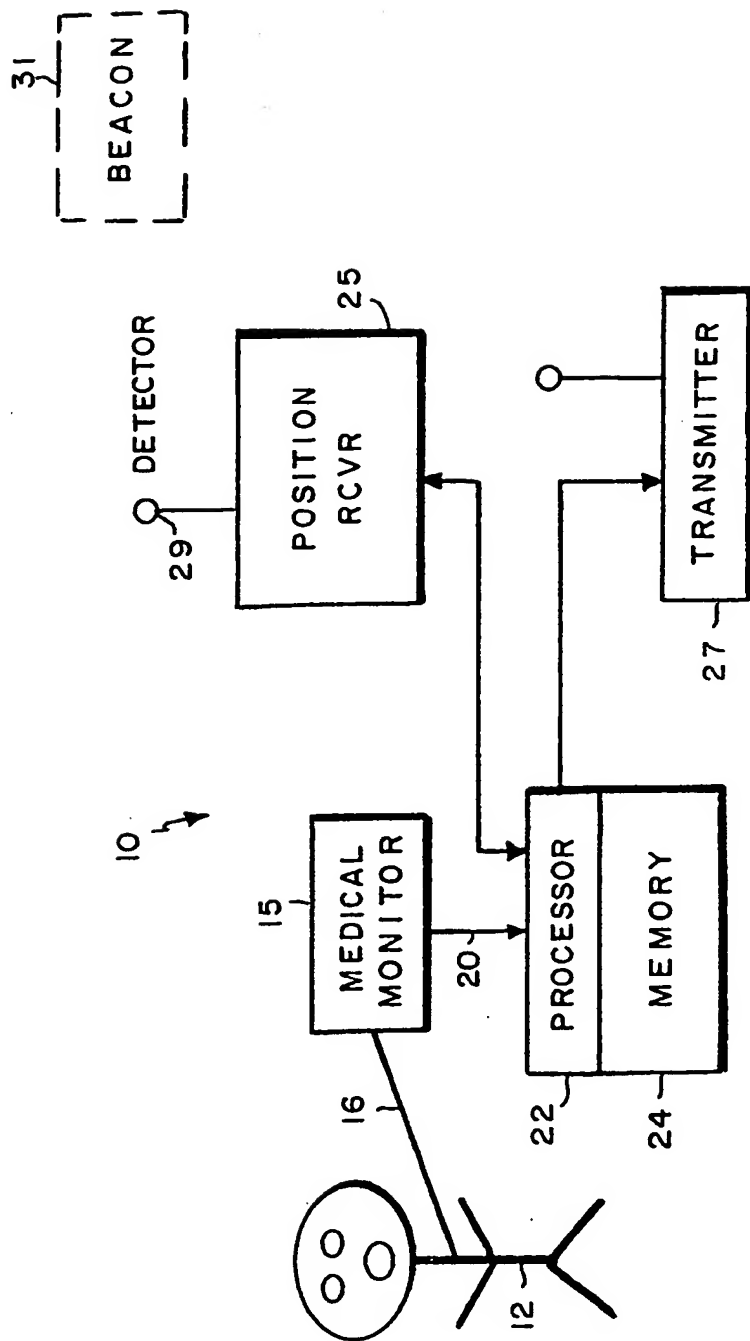


FIG. 1A

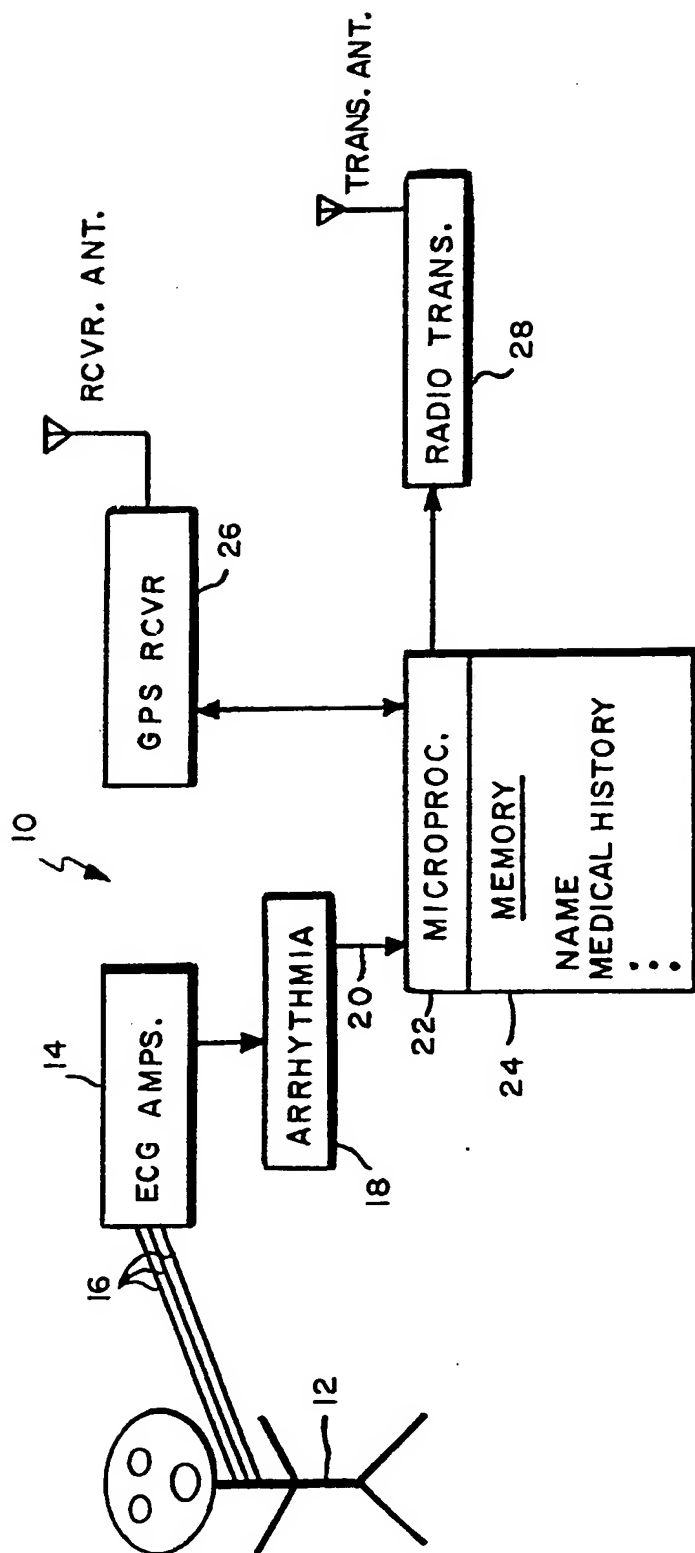


FIG. 1B

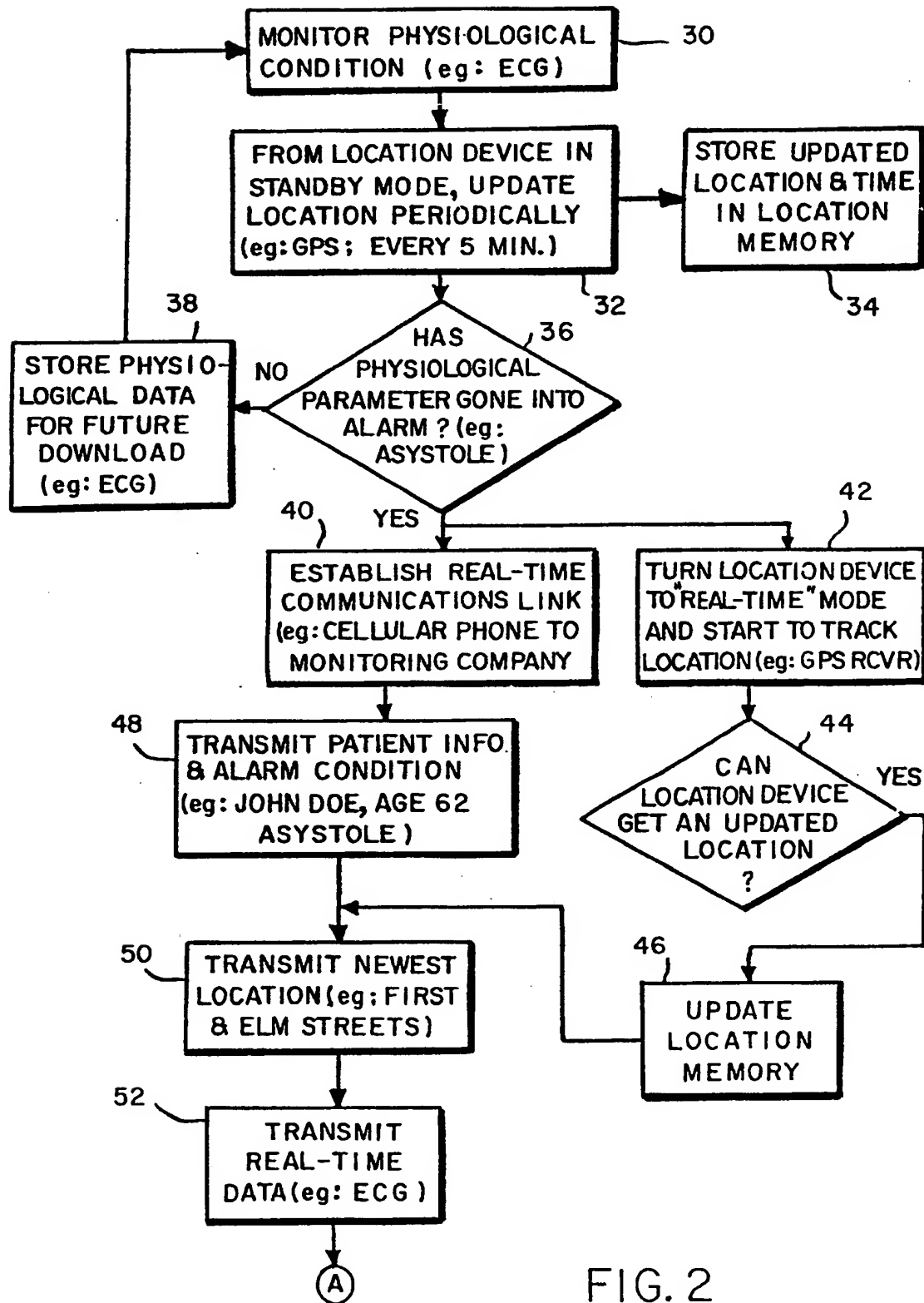


FIG. 2

**EMERGENCY RESPONSE SYSTEM**

This invention relates to an emergency response system and to a method of providing emergency response, for example a system worn by a patient which facilitates rapid response to a patient medical emergency or a system which monitors both a potential emergency medical condition of the patient and the patient's location, and which provides both forms of information to an emergency medical service (EMS) or other appropriate medical center in the event an emergency medical condition is detected.

There are many patients who are at risk for a medical event requiring rapid response by EMS personnel for the patient to have a reasonable expectation of recovering, and in many instances in order for the patient to survive. The most common such medical event is a life-threatening ectopic heartbeat which is designated as a situation where the patient either has no heartbeat or the heart is

in fibrillation (the heartbeat is fluttering). In such a situation, cardiopulmonary resuscitation (CPR) and/or defibrillation must be initiated within four minutes to prevent brain damage. If a much greater period of time passes, the patient will die. Other conditions which might give rise to an emergency medical situation include patients with serious asthma, emphysema or other breathing problems who, when they experience an attack, could die if oxygen is not quickly administered, severe diabetic patients who require emergency medical attention if they go into diabetic shock, epileptics who are subject to severe seizures and others. In many instances such patients are kept in a hospital, nursing home or other such facility so that appropriate medical procedures can be quickly administered in the event a medical emergency arises. However, maintaining patients in such facilities is expensive and the restrictions on patient mobility required for such facilities significantly reduces the patient's quality of life. Further, even when a patient is in such a facility, if the patient is permitted to move about the facility rather than being confined to his bed or room, problems may arise both in determining when the patient requires emergency assistance and in quickly locating the patient when emergency assistance is required.

It would therefore be desirable if such patients could be permitted to lead more normal lives while assuring that EMS, hospital or other appropriate personnel could rapidly reach the patient in the event a medical emergency should arise. While the response capability of EMS teams to an emergency call is generally adequate, particularly in most metropolitan areas, to deal with such medical emergencies within the required time, there are a number of factors which typically delay the arrival of an EMS team to a patient experiencing a medical emergency which significantly reduce the likelihood of patient survival.

The first problem is the time between the onset of the medical emergency and a call being placed to 911 or other appropriate emergency response number. This problem can result from the patient being alone when the medical emergency occurs (i.e. unwitnessed emergencies), from the medical emergency not occurring near a telephone where the call could be placed or from people in the area of the patient not realizing that the patient is undergoing a medical emergency and that an immediate call for assistance is required. These delays are frequently sufficient so that the patient has died long before a medical emergency team arrives.

The second problem is one of locating the patient. While "Enhanced 911" service which is

available in some areas permits location of the telephone from which the call was placed to be determined even if the person placing the call does not provide adequate or accurate information on location, the patient may frequently be at some distance from the telephone from which the call was placed, an effort may be made to move the patient to a more comfortable location after the call is placed or the call may be placed from a phone which is not in the 911 location database. In the many areas where Enhanced 911 service is not available, the EMS team can only rely on the frequently sketchy information provided by the caller, significantly complicating the problem of locating the patient, and thus significantly increasing the response time from onset of the medical emergency to the initiation of appropriate treatment.

A third potential problem arises from the fact that there are generally enough confounding variables to confuse the medical situation so that responding EMS personnel must spend precious minutes trying to diagnose the patient's condition to determine an appropriate medical response. This may involve the EMS personnel making an initial assessment of the situation, determining what, if any, tests are required to further assess the situation and retrieving appropriate equipment to deal with the condition once the problem has been



determined. Since the person suffering the medical emergency frequently is not known to the caller and the patient's identity is not conveyed to the EMS personnel, they do not have a medical history on the patient when they arrive and, therefore, do not have the benefit of such information in determining the patient's problem and appropriate response. This can be a particular problem where a patient is allergic to a particular medication or where the patient requires a non-standard treatment for their condition.

Similar problems to those described above may also arise in a hospital or other facility when a patient is permitted freedom of movement through the facility. However, since patients retained in such facilities are generally in weaker physical condition, the permitted response time to a medical emergency for such patients may be even shorter. In particular, unwitnessed emergencies can be as much a problem in such a facility as outside and locating a patient, particularly in a relatively large facility, when an emergency occurs can also be a problem. Properly identifying the patient having an emergency, determining the exact nature of the patient's problem and its progress and being sure that responding personnel are aware of appropriate medical procedures are also as important in a hospital or other institutional setting as for

medical emergencies arising outside of such facilities.

The present invention seeks to provide an emergency response system.

According to an aspect of the present invention, there is provided an emergency response system for a patient comprising:

- a monitor for detecting a selected emergency medical condition for the patient and for providing a selected output in response to the detection of said condition;

- a position receiver for receiving and storing information concerning the position of the patient; and

- a transmitter operative in response to said selected output for transmitting stored position information to a selected site.

According to another aspect of the present invention, there is provided a method of providing emergency response to a patient comprising the steps of:

- monitoring a selected medical condition of the patient;

- detecting if the medical condition goes into an emergency alarm condition state;

- storing a position indication of the patient; and

- transmitting an indication of the medical condition emergency alarm and the stored position indication to a selected site in response to a detected emergency alarm condition.

It is possible with preferred embodiments to provide an emergency medical response system which permits information on a medical emergency to be

immediately transmitted to an appropriate center as soon as the emergency arises, with the center also automatically receiving information on the patient's current location, information on the nature and extent of the patient's medical emergency and other useful information on the patient such as the patient's name and relevant medical history. This embodiment can also monitor the information on the patient's location and current status on the medical emergency situation, continuously or at least regularly, after the onset of the medical emergency and send updated information to the center to assist EMS or other responding personnel in rapidly locating the patient and to assure that such personnel arriving at the scene are fully knowledgeable concerning the patient, his medical history and the current problem he is experiencing. For emergencies occurring outside an institution, this information could also be transmitted either directly or by the EMS center to the emergency department of the receiving hospital to assure proper preparation for patient arrival. Such a system can therefore significantly enhance the likelihood of survival and recovery for patients experiencing medical emergencies while still permitting patients prone to such emergencies to live reasonably normal lives.

The preferred embodiment consists of three basic components. The first component is a monitor for detecting a potential emergency medical condition for the patient and for providing a selected output in response to the detecting of such condition. Where the condition being monitored is a heart condition, the monitor could include an ECG monitor and an analyzer for the output from the ECG monitor, the analyzer detecting life-threatening ectopic beats, or other life-threatening conditions. In the output from the ECG monitor and generating a selected output in response to the detection of such condition. When the condition being detected is an asthma or emphysema attack, a respiration monitor would be utilized. A glucose

measuring device could be utilized for detecting diabetic shock and a brainwave monitor for detecting epileptic seizures.

The second component is a position receiver, for example a global position system (GPS) receiver, for receiving and storing information concerning the position of the patient. In an institutional application, the receiver may respond to an infrared (IR) network. For example, each room or other area of the institution could have an IR beacon which generates a unique code. The code received and stored by the receiver is thus an indication of location.

The third component is a radio or other transmitter which is operative in response to an output from the monitor for transmitting the stored position information to an emergency medical center. At the same time the transmitter sends the global or other position information, it also sends information stored in the system which identifies the patient. To the extent the receiving center has access to medical files on patients in its system, information such as the patient's name or a coded identification of the patient is sufficient to permit the retrieval of the patient's medical history so that such information may be provided to the responding emergency personnel. To the extent medical history information cannot be easily retrieved, relevant information on the patient's medical history would also be stored and transmitted when the medical emergency is detected. Finally, information from the monitor indicating the nature and extent of the medical emergency would also be transmitted at this time.

Once the preferred system detects a medical emergency, it monitors the medical condition of the patient, either continuously or at regular intervals, and transmits updated medical information to the emergency center so that the responding medical personnel can be kept apprised of the patient's condition. Further, while this system, and in particular the GPS or other position receiver portion thereof, would normally be in a stand-by mode before a medical emergency condition is detected, the GPS receiver being operative to periodically update stored position information when in this mode, the system goes into a real-time mode after a medical emergency is detected with the GPS system being operative to regularly track the position of the patient in this mode. Any change in the position of the patient would also be transmitted to the emergency center to facilitate location of the patient.

The system could include a microprocessor or other suitable processor for control thereof. In particular, the processor could receive outputs from the monitor and position receiver, control transfers of information from the monitor and position receiver to the transmitter and control at least in part the operation and interaction of the monitor, position receiver and transmitter.

An embodiment of the present invention is described below, by way of example only, with reference to the accompanying drawings, in which:

Fig.1A is a generalized block diagram of an embodiment of monitoring system;

Fig.1B is a more detailed block diagram of the system of Fig.1A;

Fig.2 is a flow diagram of an embodiment of operation of a system shown in Fig.1B.

Referring to FIG. 1A, a system 10 is shown which monitors a patient 12 for an emergency or life-threatening medical condition and transmits an alarm when such condition is detected. The life-threatening condition may be, as previously indicated, a heart condition such as an ectopic heartbeat, may be a breathing problem such as asthma, may be a diabetic condition, a neurological problem such as epilepsy, or other emergency medical condition which might result in death or serious injury to the patient. The system also monitors the location of the patient and provides information both on the patient's location and on the patient's

medical condition when a medical emergency alarm occurs. Additional information concerning the patient, including selected information on the patient's medical history, may also be provided at such time.

More particularly, the system 10 includes a medical monitoring device 15 which is connected to patient 12 in standard fashion by one or more leads 16. Medical monitor 15 would be an appropriate device for monitoring the condition of concern for the particular patient. For example, where the condition being monitored is a heart condition, monitor 15 could include an ECG monitor 14 (FIG. 1B) and an analyzer 18 for the output from the ECG monitor, the analyzer detecting life-threatening ectopic beats or other life-threatening conditions in the output from the ECG monitor and generating a selected output in response to the detection of such condition. When the condition being detected is an asthma or emphysema attack, a respiration monitor would be used as the medical monitor 15. A glucose measuring device could be used as the monitor 15 for detecting diabetic shock and a brainwave monitor for detecting epileptic seizures. Other suitable medical monitors could be used as the monitor 15 as appropriate for various medical conditions.

An output appears on line 20 from monitor 15 when an emergency medical condition is detected.

This output is applied to a processor 22 which may be a standard, suitably programmed microprocessor or may be a special purpose processing device or chip which is fabricated and/or programmed for the required functions. The operation of processor 22 and of memory 24 associated therewith, which memory may contain selected information concerning the patient, such as the patient's name, medical history and the like, will be discussed in greater detail in conjunction with the discussion of FIG. 1B and of FIG. 2.

Processor 22 also receives an input from a position receiver 25 which receives suitable electrical inputs from a detector 29. For applications outside an institution, receiver 25 would preferably be a global position sensor (GPS) receiver, but as will be discussed in greater detail later, other suitable receivers might be utilized. For applications inside of an institution, position receiver 25 might be an IR or possibly a radio frequency (RF) receiver receiving inputs from an IR or RF detector or radio signal detector (i.e. antenna) 29. In such application, a beacon 31 (shown in dotted lines in FIG. 1A since such item is optional for non-institutional applications) generates a coded output unique to a particular location. Such an infrared beacon could be battery-operated or could be plugged into a standard



electrical output, and is therefore easy to install, to use and to configure or reconfigure as required without time-consuming and expensive rewiring. The beacon may be placed in a room, hall, or other area to which patients have access. When the patient is in such area, detector 29 picks up the beacon and the corresponding coded indication is stored either in receiver 25 or processed by receiver 25 and stored directly in processor 22.

While an IR beacon and receiver are preferable for institutional applications because IR beams do not pass easily through walls, but instead bounce around within an enclosed space to assure full coverage of the space, less beacons may be required if the beacons are RF beacons. However, since RF beacons would not offer as precise location information, standard triangulation techniques from at least two and preferably three RF beacons might be required for good patient location, the relative strengths of the beacons at the receiver being used to determine location.

When processor 20 received an emergency signal on line 22, it sends a signal to transmitter 27, which is a radio transmitter for preferred embodiments, to activate the transmitter. The processor then sends to the transmitter information from its memory identifying the patient, indicating the nature of the medical emergency and an

indication either from receiver 25 or from its own memory of the patient's current location. In an institutional environment, such radio signals would be picked up at a central location in the hospital and appropriate personnel immediately dispatched to the indicated location with appropriate equipment to deal with the emergency. The way in which the situation is handled when the system is being used with a patient outside of an institution will be discussed later in conjunction with FIGS. 1B and 2.

FIG. 1B is a more detailed block diagram of a system which is particularly adapted for monitoring a heart arrhythmia for a patient located outside of an institutional environment. Referring to FIG. 1B, the system 10' includes an ECG monitor front end 14 which is connected to patient 12 in standard fashion by one or more leads 16. In a typical application, there might be three leads 16, at least one of which is affixed to the patient's chest in the area of the heart. ECG front end 14 could be a small, low power, portable unit such as that utilized in the Hewlett-Packard M1400A telemetry transmitter and in the Hewlett-Packard 43400B Holter Analyzer.

The heartbeat information detected by front end 14 is applied to an arrhythmia detection unit 18 which analyzes the incoming heart rhythm and determines if it has any abnormalities. A small, low power version of such a programmable processor

is currently implemented in the Hewlett-Packard 43400B Holter Analyzer. Thus, a 43400B Holter Analyzer could be used to perform the functions of the ECG front end 14 and arrhythmia detector 18. An arrhythmia detector unit 18 would typically be a general purpose microprocessor which is programmed to detect a certain type of arrhythmic condition, for example a life-threatening ectopic heartbeat for preferred embodiments of this invention. This could be done by having the unit "learn" and store the normal heart pattern for the patient over a number of cycles, and then detect selected variations in this pattern, for example by pattern matching, to determine alarm conditions. Alternatively, special purpose circuitry may be provided for performing the functions of arrhythmia detector 18. Selected cardiac events may be stored in a memory of arrhythmia detector 18 for later use and this unit may also be programmed to generate an output on line 20 to microprocessor 22 when, for example, a life-threatening condition is detected.

Microprocessor 22 receives information and sends information to various elements in system 10' and is programmed to control the operation thereof. The control functions performed by microprocessor 22 will be discussed later in conjunction with the flow diagram of Fig.2. Microprocessor 22 has a memory

24 associated therewith which may be loaded to contain selected information on the patient and on the patient's medical condition. Such information may include, but is in no way limited to, the patient's name, a summary of the patient's medical history with particular emphasis on the medical condition being monitored, for example on cardiac matters relevant to the life-threatening alarm situation, preferred treatments for this patient, any drug allergies or other cautions to be exercised in treating the patient and the like. Where a dedicated arrhythmia detector, such as a Holter Analyzer, having an internal arrhythmia unit 18 is not utilized as the ECG monitor, microprocessor 22 may also be programmed to perform the functions of unit 18 and the arrhythmia unit 18 may be dispensed with. Alternatively, where the microprocessor being used for the arrhythmia unit 18 has sufficient capacity, it may be programmed to perform the control functions of microprocessor 22, and this unit may be dispensed with.

Microprocessor 22 receives inputs from a GPS receiver 26 and provides controls to this receiver. GPS receiver 26 may be a standard commercially available receiver of this type which periodically receives satellite generated signals and, in response to such signals, stores the current latitude, longitude, and in most cases altitude

(i.e. elevation above sea level) for the receiver. Examples of GPS receivers suitable for performing this function are the Garmin GPS100MRN GPS receiver and the Magellian NAV1000PRO receiver.

Alternatively various GPS receiving circuit IC chip sets may be utilized, for example, the GEC Pleasey GP1010 family of GPS receiving circuits or those of Harris Semiconductor. Receivers of this type provide reasonably accurate position location (generally within about 10 meters) after approximately 2 minutes from start-up. While these receivers are generally fairly small and light, and require relatively little power, these units, which are designed primarily for aviation and navigation applications, generally have many features which would not be necessary for practicing the teachings herein and the elimination of these features from a GPS receiver designed specifically for this application could result in further reductions in size, weight, power consumption and complexity for the receiver 26. This would also further reduce the cost of the unit.

While GPS receivers are considered preferable for this application because of the ready availability both of relatively small, lower power, inexpensive GPS receivers and because of the fact that the technology is in place for permitting such receivers to be utilized in most areas of the world,

other types of position detection and storing devices may also be utilized. For example, a suitable transangulation system such as Loran may in some applications be substituted for the GPS receiver 26.

The final element in the system is a radio transmitter 28 which receives information to be transmitted from microprocessor 22. This would be a low power radio transmitter. Examples of existing technology which could be utilized for radio transmitter 28 include cellular mobile radio, private land mobile radio, or a nationwide messengering service such as the RAM Mobile Data system. Where a cellular phone system is utilized, microprocessor 22 would cause transmitter 28 to dial a selected telephone number for an EMS center. If the patient is moving only within a limited geographic area within one area code, this number could be a local number. Alternatively, the number dialed could be a nationwide 800 number so as to permit the patient a wider range of geographic movement. The system 10' is also compatible with various future radio technologies which might, when available, be utilized. Such technologies include CT2, GSM, IRIDIUM, or any of the various PCN schemes. Once

microprocessor 22 determines that a radio link has been established with the EMS center, it is programmed to down-load information to transmitter 28 for sending to the EMS center in a manner to be described shortly.

The operation of the system shown in FIG. 1B will be described in conjunction with the flow diagram of FIG. 2. Initially, patient 12 is fitted with system 10', which may, for example, be belt-mounted and battery powered, by appropriate medical personnel. Lead(s) 16 could either be surgically implanted or the patient taught how to replace them after bathing or the like.

Referring now to FIG. 2, the system normally monitors a physiological condition of patient 12 (step 30) by use of suitable monitoring equipment (for example ECG front end 14). At the same time monitoring step 30 is being performed, GPS receiver 26 is operating, preferably in a stand-by mode wherein the position indication stored therein is periodically updated, for example every five minutes (step 32). The position information acquired during step 32 is stored in a location memory of the GPS receiver 26 during step 34. The reason steps 32 and 34 are performed is that GPS receivers typically do not work well inside a building or in other shielded environments. Therefore, it is desirable to have a recent position indication for the patient in the

event a medical emergency situation should arise at a time when the patient is in a location where updated position information cannot be easily obtained. Other location techniques, for example microcellular based, may eliminate this problem. This also would not be a problem with the beacon (IR or RF) technique discussed earlier in conjunction with FIG. 1A.

During step 36, which is performed concurrently with steps 30-34, microprocessor 22 monitors the output from arrhythmia unit 18 to determine if a physiological parameter has gone into an alarm condition (i.e. a life-threatening ectopic heartbeat for the preferred embodiment). If a negative response is obtained during step 36, the operation proceeds to step 38 to store the current physiological data, for example the current heartbeat data, in either a memory in arrhythmia unit 18 or in memory 24. Steps 30-38 are repeated in selected sequence under control of microprocessor 22 so long as an alarm condition is not detected at the patient.

If, during step 36, it is determined that the patient is experiencing an emergency medical condition, for example a life-threatening ectopic heartbeat, the operation proceeds to perform both steps 40 and 42. During step 40, radio transmitter 28 under control of microprocessor 22 establishes a



real-time communications link with an EMS center, for example by placing a telephone call to the EMS center through a cellular phone network. During step 42, GPS receiver 26 is switched to a real-time mode wherein patient position is monitored and updated substantially continuously (for example at intervals of one minute or less) rather than at intervals of several minutes. From step 42, the operation proceeds to step 44 to determine if the location device can get an updated location. Typically, a "yes" output will be obtained during step 44 and the GPS position stored in receiver 26 will be updated during step 46. However, as previously indicated, where the patient is inside a building or in some other electromagnetically shielded location, it may not be possible to successfully do position updates during steps 42 and 44 and a "no" output will be obtained during step 44 resulting in step 46 not being performed.

From step 40, once the communications link has been established, the operation proceeds to step 48 to transmit patient information and an alarm condition to and through transmitter 28 and the established communication link to the EMS center. The information transmitted would be the information stored in memory 24 which, as previously indicated, might include the patient's name, biological information on the patient such as his age, weight,

sex and the like and relevant information from the patient's medical history. The detected alarm condition would also be transmitted at this time as would the most recent physiological data stored during step 38. The EMS center would contain suitable receiving equipment for the received information, for example a standard modem, and a computer programmed to respond to a received alarm indication to trigger a suitable alarm at the center. Other received information would be suitably processed and either directly transmitted to responding EMS personnel or displayed for oral transmission. Appropriate information may also be either directly transmitted or retransmitted by the EMS center to the emergency department of the receiving hospital to facilitate treatment once the patient is brought in.

From steps 46 and 48, the operation proceeds to step 50 to transmit the newest location information concerning the patient. This information would typically be latitude, longitude and generally altitude elevation information, but could be converted by suitable programming to an address or other suitable form. Alternatively, such conversion could be done at the EMS center. In some applications, it might be desirable to overlap the transmitting of the information during steps 48 and 50, with information on an initial position being

provided to the EMS center after the patient is identified and the alarm condition specified, and the remaining biographic and medical history information on the patient being transmitted after the position information has been transmitted. This permits the dispatching of EMS personnel to the patient as rapidly as possible.

While step 48 would typically only be performed once when the emergency condition is detected, step 50 is repeated at frequent intervals, for example every minute, so that movement of the patient may be tracked and the EMS personnel sent to the patient's current location. In addition, ECG front end 14 continues to operate during this period with data from the front end being transmitted to microprocessor 22 and being sent for transmission by transmitter 28 on a continuous basis (step 52).

Thus, as EMS personnel are responding to the call, they can continue to receive updated information on the patient's location and on the patient's emergency medical condition so that they can rapidly locate the patient and will know exactly what needs to be done when they arrive on the scene. Precious time normally lost in locating the patient and in determining what needs to be done to aid the patient are thus saved. The system also assures that the EMS personnel are knowledgeable concerning any unique medical conditions of the

patient which may dictate non-standard treatment procedures, including any allergies to medications which the patient may have. This assures that inappropriate or potentially dangerous medical procedures are not taken on the patient. Steps 46, 50 and 52 are performed at frequent intervals, for example every minute, until the EMS personnel arrive at the patient and initiate appropriate medical procedures.

Thus, a relatively simple emergency medical monitoring system is provided which overcomes many of the deficiencies of prior art systems and which, in particular, facilitates rapid response to a medical emergency, even in situations where the patient is alone when the event occurs, while maximizing the amount of information which medical personnel have when they arrive at the scene.

While for the preferred embodiment described above, the monitor for the patient is a Holter Analyzer or other appropriate ECG monitoring device, as has been previously discussed, where the potential emergency medical condition for the patient is a breathing condition, diabetic condition, epileptic or other neurological problem or the like, appropriate monitors for such condition may be substituted for monitor 14 and analyzer 18. Further, while all information for the preferred embodiment is sent to an EMS center and/or to a

hospital center, such information could be transmitted to another selected location, including being routed directly to the EMS personnel responding to a call. Other appropriate changes, many of which have been described above, may also be made in the system.

The equipment is also suitable for use, particularly when utilized in an institutional setting, to provide periodic indications of both a patient's medical condition and his location so that both may be tracked by medical personnel without unduly inhibiting the patient's freedom of movement. Such monitoring would permit appropriate action to be initiated if the monitor indicates that the patient is in some distress, even though not in an emergency situation, or if it is determined that the patient has either wandered too far from available assistance or into areas restricted for such patient. The operation when operated in this mode would be substantially the same as the operation described previously, except that an output on line 20 would appear at periodic intervals or processor 22 would query monitor 15 at periodic intervals and transmit information on medical condition and location to an appropriate center rather than doing so only when a medical emergency

is detected. The combination of a beacon 31 and position receiver 25 for permitting patients or others to be located in an institutional environment could also be utilized, with the position of the patient or other individual being periodically transmitted to a central station with an identifier for the individual, but without additional medical information. Such systems might be useful in mental institutions or old-age homes in addition to hospitals and might also be utilized in non-medical situations such as prisons to track the location of personnel or in various secure facilities.

The disclosures in United States patent application no. 08/168,702, from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.

Claims

1. An emergency response system for a patient comprising:  
a monitor for detecting a selected emergency medical condition for the patient and for providing a selected output in response to the detection of said condition;  
a position receiver for receiving and storing information concerning the position of the patient; and  
a transmitter operative in response to said selected output for transmitting stored position information to a selected site.
2. A system as claimed in claim 1, wherein said monitor is operative to continue to detect said medical condition after providing said selected output and to provide an output for transfer to said transmitter.
3. A system as claimed in claim 1 or 2, wherein said monitor includes an ECG monitor, and an analyzer coupled to the output from said ECG monitor for detecting selected ectopic beats in said output and for generating said selected output in response to the detection of such beats.
4. A system as claimed in claim 3, wherein said monitor includes a Holter Analyzer.
5. A system as claimed in any preceding claim, including a microprocessor coupled to the output of the monitor and of the position receiver and operative to control transfer of information from the monitor and position receiver to the transmitter, and to control at least in part the operation and interaction of the monitor, position receiver and transmitter.
6. A system as claimed in any preceding claim, wherein at least said position receiver is operative to be in a stand-by mode before said selected

output is provided and is in a real-time mode after the selected output is generated, wherein said position receiver is operative to update periodically stored position information when the system is in stand-by mode and to track position regularly when the system is in real-time mode.

7. A system as claimed in any preceding claim, including a storage device for storing predetermined information concerning the patient, and means responsive to said selected output for causing said transmitter to transmit said information to said selected site.

8. A system as claimed in claim 7, wherein said predetermined information includes one or more of the patient's name or other ID, biological data on the patient, medical information on the patient and the patient's medical history.

9. A system as claimed in any preceding claim, wherein said monitor includes means for measuring a predetermined physiological parameter, which parameter is related to said emergency medical condition.

10. A system as claimed in any preceding claim, wherein said transmitter includes cellular communications components.

11. A system as claimed in any preceding claim, wherein said position receiver is a GPS receiver.

12. A system as claimed in any preceding claim, wherein said position receiver is operative to receive signals within a selected frequency band and from at least one beacon transmitting a location code at a frequency within said selected frequency band.



13. A system as claimed in claim 12, wherein said selected frequency band is an infrared band.

14. A method of providing emergency response to a patient comprising the steps of:

monitoring a selected medical condition of the patient;

detecting if the medical condition goes into an emergency alarm condition state;

storing a position indication of the patient; and

transmitting an indication of the medical condition emergency alarm and the stored position indication to a selected site in response to a detected emergency alarm condition.

15. A method as claimed in claim 14, including the steps of:

storing predetermined information concerning the patient, including at least one of a patient ID, biological data on the patient and medical information on the patient; and

transmitting the stored selected information to the selected site in response to said emergency alarm condition.

16. A method as claimed in claim 14, wherein the step of storing a position indication of the patient includes the steps of periodically determining the current position of the patient; and storing the determined current position as the position indication for the patient.

17. A method as claimed in claim 16, wherein the current position of the patient is determined and stored at more frequent intervals in response to the detection of said emergency alarm condition, wherein each stored position indication is transmitted to said selected site.

18. A method as claimed in claim 17, wherein, in response to the detection of said emergency alarm condition, the monitored medical condition is transmitted to said selected site.

19. An emergency response system substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

20. A method of providing emergency response to a patient substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



Application No: GB 9425034.7  
Claims searched: 1

Examiner: R S Clark  
Date of search: 20 March 1995

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.N): G1N (NEAE, NEAN, NEAX, NESS)

Int CI (Ed.6): A61B 5/00; G08C 17/02

Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	US 4958645 (CADELL) whole document	1-5, 7-9, 12-16, 18

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.